

CHAPTER VI.

TYPES AND CONSTRUCTIONS OF HOUSEHOLD REFRIGERATING MACHINES.

Household Refrigerating Machines.—In this chapter, attention will be given to the general types and characteristic construction of a number of household refrigerating machines, which are being produced at present. The makes of the various household refrigerating machines which are described here, have been selected promiscuously, and represent the characteristic design of the different classes of machines. It does not include descriptions of all of the different makes of household machines, since, at present, there are over sixty different makes being produced.

In the following, special attention has been given to the mechanical design of the different parts of the different systems. They are classified as to the refrigerant used.

Brunswick-Kroeschell Portable Ice Making Plant.—Fig. 13 shows a complete portable ice making plant built by the Brunswick-Kroeschell Co., of New Brunswick, N. J.

This plant is shipped complete, charged with ammonia ready to make ice when connected to power and water supplies. It is operated by a 1-hp. motor. It is not automatic; however, its operation is comparatively simple.

The capacity of this model is 100 to 125 pounds of ice each 8 to 10 hours of operation. This machine is also supplied to cool refrigerator cabinets of about 100 cu. ft. food storage

space. A larger plant of the same type with twice the above capacity is also manufactured.

When these plants are operated by a gasoline or kerosene engine, the manufacturer recommends that a $1\frac{1}{2}$ - or 2-hp. engine be used to drive the size plant which is operated by a 1-hp. motor.

The ammonia compressor is of the single-acting, vertical enclosed type. All joints are ground, thus eliminating the use of gaskets and assuring permanent alignment of all parts. The drive shaft is sealed with a special metallic packing.

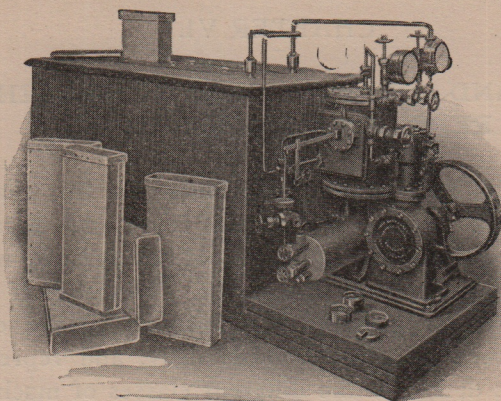


FIG. 13.—BRUNSWICK-KROESCHELL PORTABLE ICE MAKING PLANT.

The discharge valve is the full size of the cylinder. A safety relief valve is located in the face of the discharge valve.

The piston is fitted with two sets of rings, one set known as the compression rings, being located above the suction inlet; the other set below, called the oil rings. The low pressure gas enters the cylinder through the piston, below the compression rings, so there is no need of an equalizing pipe between the crank-case and the suction line, since under normal conditions the pressure in the case will not be greater than the suction pressure.

The lower set of rings prevents the oil from passing too freely into the cylinder. These rings are ground on all four sides to insure a perfect fit.

An eccentric drive is used instead of a crankshaft. The

eccentric is cast in one piece and is shrunk on the shaft. The eccentric strap and crank pin are of one piece.

Larger ammonia plants are made as well as carbonic type compressors. The smallest size carbonic compressor is rated at 1 ton refrigeration per 24 hours.

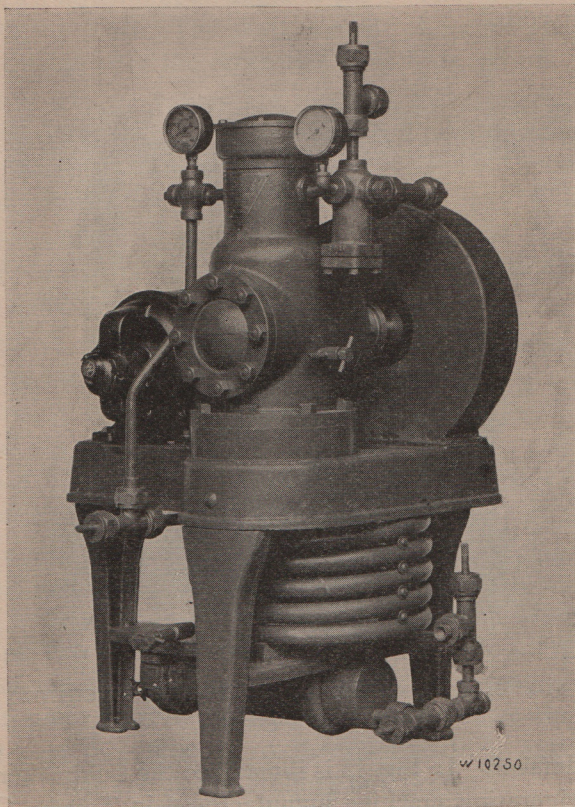


FIG. 14.—UNIVERSAL REFRIGERATING MACHINE.

Universal Refrigerating Machine.— Fig. 14 shows the household compressor unit manufactured by the Universal Ice Machine Co., of Detroit.

The refrigerant used is ammonia. A $\frac{1}{2}$ -hp. motor drives the compressor by means of a V type leather belt and idler

pulley. The compressor has a special type aluminum piston, designed to assure good lubrication and eliminate wear on the sides of the cylinders.

Disc plate suction and discharge valves are used. These are located in the head of the compressor and are easily accessible. The cylinder head is water jacketed. Metallic packing is used on the compressor crankshaft. The condenser is made of a double spiral coil with welded ends. Water flows through the inner coil.

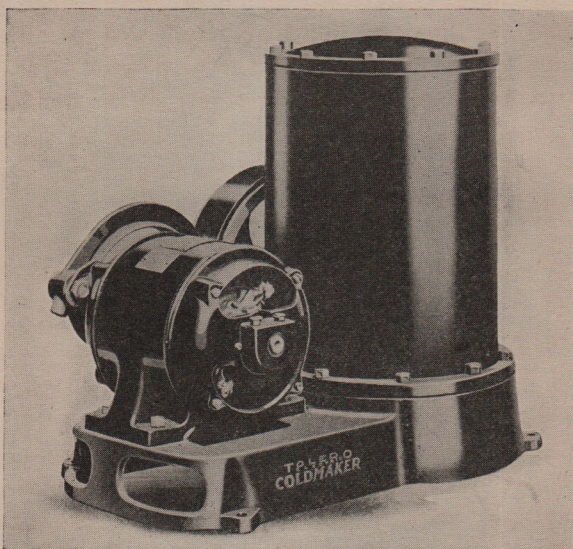


FIG. 15.—COLDMAKER REFRIGERATING MACHINE.

Coldmaker.—In Fig. 15 is illustrated the Coldmaker household refrigerating machine manufactured in Toledo, O. The machine is installed in the basement or other out of the way place and the cooling coils are installed in the ice compartment of any box.

Coldmaker consists of a water cooled ammonia system of automatic refrigeration. The compressor is motor driven by means of a flat leather belt.

The compressor has two cylinders, $1\frac{1}{4}$ inches in diameter

by $1\frac{1}{4}$ inch stroke made of a semi-steel casting. Suction port openings are located near the center of the cylinders.

The pistons have long ports on each side to admit the suction gas. The suction valve is located in the upper end of the piston. The top end of the piston has four piston rings and the lower end three rings. The wrist pins are made of nickel steel. The eccentrics are made of gray iron castings and are cast integral at an angle of 180° . They are shrunk and pinned to the shaft. The shaft is made of forged steel and is ground to size after the eccentrics have been shrunk on.

The discharge valves are made of nickel steel, light in weight, and cup shaped. They give full area opening of the cylinder and permit the compressor to handle saturated gas or liquid without endangering the safety of the machine.

The suction valves, located in the head of the pistons, are made of nickel steel. They have a large suction area and operate with a minimum lift.

Both suction and discharge valves are provided with springs to hold the valves snugly to seats when the pressure is released.

The end plates containing the shaft bearings are made of semi-steel, bored and reamed accurately, and fitted with die cast bearings.

The stuffing box is provided with an oil gland, or ring, with soft packing on both sides. The gland has a direct connection with an oil reservoir, entirely separate from the oil in the crank case. This in reality, forms an oil storage in the center of the stuffing box, which keeps the packing soft and resilient, and effectively seals the stuffing box so that no gas can get past this oil seal. A threaded packing nut or gland forms the outer end of the stuffing box proper.

The rings are made of soft, close grained gray iron. Each ring is cast individually and the inner surface is left unfinished to give toughness and resiliency to the ring. The rings are cast eccentric.

The cylinder heads are made of semi-steel. The discharge port is located in the cylinder head.

The water jacket surrounds the compressor, condenser

and liquid receiver. Any leak which might occur will be absorbed by the water.

The condenser is made of extra heavy $\frac{1}{2}$ -in. steel pipe bent to shape and surrounding the compressor cylinders.

Some advantages of the water jacket surrounding the compressor, condenser and liquid receiver are:

1. It absolutely assures splendid operating conditions for the compressor, preventing any contraction or expansion of the metals.
2. It prevents the oil from vaporizing in the crank case.
3. The bearings are kept at a uniform temperature and prevented from overheating.
4. It keeps the stuffing box in excellent condition at all times.
5. It gives additional condensing surface on the receiver.
6. Provides a direct outlet to the sewer in case of leaks.

The expansion valve is of the diaphragm pressure type. It is screened to prevent dirt and scale from getting to the valve seat.

The automatic control consists of a small 1/50-hp. motor which is reduced in speed by worm gears. One of these is directly connected to a rotating shaft, which contains on one end the rotary switch with three terminals corresponding to the three terminals on the thermostat, and the two terminals for the power motor switch. On the other end is fixed the water cock for regulating the flow of water to the condenser shell. As both switches and water valve are firmly fastened to the same shaft and rotate at the same time, it is plainly evident that both water and current must be on or off at the same time.

If the water supply fails, a diaphragm pressure switch directly connected to the water line cuts off the motor instantly. If the pressure falls below a safe margin, the motor will not start again until the water pressure has been again restored to normal.

With alternating-current, a repulsion-induction motor is used, continuous duty type. With direct current, a compound

wound continuous duty motor must be used. The size furnished is $\frac{1}{3}$ -hp., 1200 r.p.m.

The capacity of the Coldmaker with the usual allowances for compressor inefficiencies, plus an additional allowance because of the small size of the equipment, figures out approximately 279 pounds of refrigeration when operating 24 hours. The machine is rated at 250 pounds of refrigeration.

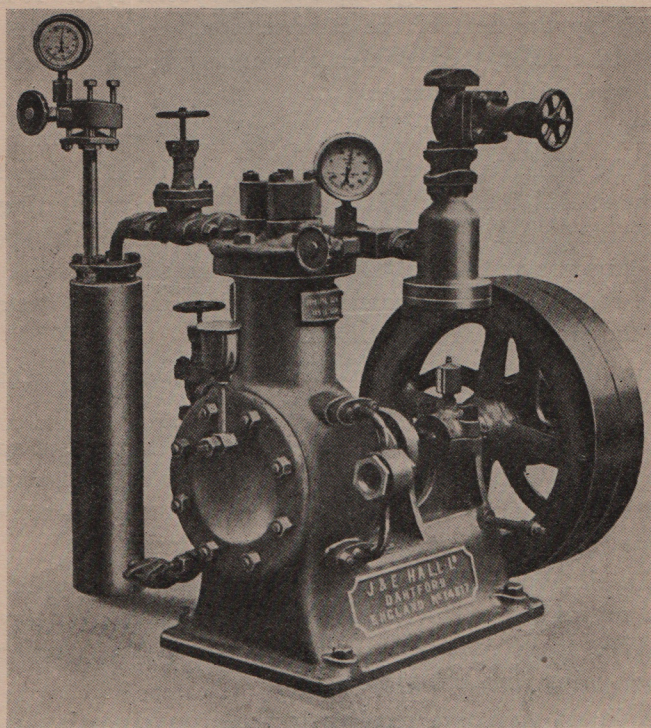


FIG. 16.—HALL REFRIGERATING MACHINE.

Doreco.—The Doreco is an ammonia absorption type household machine made by the Domestic Refrigerating Co., at Coraopolis, Pa.

This machine uses gas to heat the strong aqua solution in the generator. The condenser is water cooled. The entire operation is controlled by automatic thermostats.

A float is used to regulate the water supply, while the heating and cooling cycles are regulated by means of thermostats.

Hall Refrigerating Machine.—Fig. 16 shows the compressor of the ammonia machine manufactured by Thomas Hall & Son, Ltd., Rotherham, Eng.

The piston is of the truncated type and contains the suction valve. The discharge valve is of a special type. It is not affected by the heat of the compression. The valve is contained in a safety head which allows any liquid ammonia or oil to pass without damage.

The crank case gland screws up like a nut, which prevents the gland from being pulled on one side and thus scoring the shaft. Metallic packing is used. The connecting rod is of forged steel. The dirt separator is fitted on the suction pipe, thus preventing any scale which may become loosened in the room coils from entering the machine and interfering with the working of the valves.

An oil sight glass is fitted in the end cover, which enables the level of the oil to be seen at a glance.

The stop valves are double seating, allowing the valves to be packed while the machine is running. The machine is fitted with a purge valve on the cylinder head to enable air and foul gases to be purged out of the system.

An oil trap is fitted on the discharge and is equipped with an oil return valve which enables the oil carried over through the valve, to be returned to the crank case, thus preventing it from going into the system.

A liquid ammonia receiver is fitted underneath the condenser making a compact unit.

The method of cooling usually adopted is by means of direct expansion coils, immersed in a brine accumulator tank, which acts as a reservoir of cold and keeps the room down in temperature after the plant has been stopped. For some requirements air circulation is added. For frozen meat, direct-expansion coils are placed on the ceiling or on the walls.

This small size machine is capable of cooling a properly

insulated cold room of 400 to 500 cu. ft. to a temperature of 35° to 38° F.

Lipman Refrigerating Machine.—Fig. 17 shows the house-

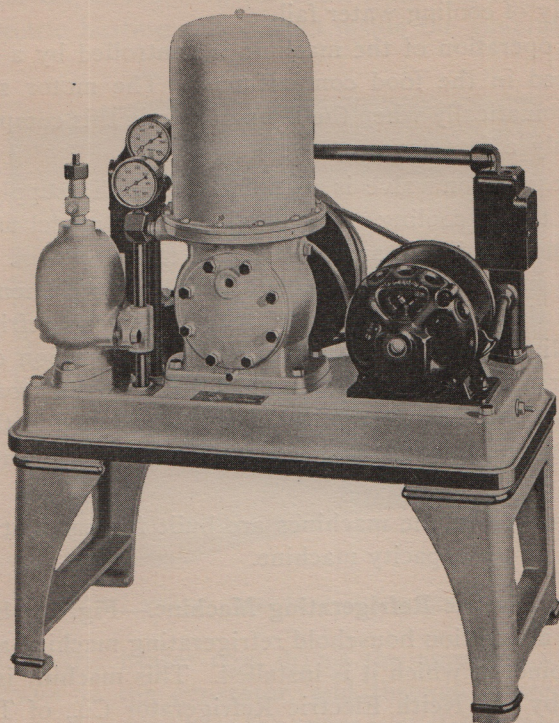


FIG. 17.—LIPMAN REFRIGERATING MACHINE.

hold size refrigerating machine, which is made by the Lipman Refrigerator Car & Mfg. Co., Beloit, Wis.

This company has specialized for years in producing refrigerating machines using ammonia as a refrigerant and operating with full automatic controls.

The motor, compressor, condenser, water valve, and high pressure cut-out, are mounted on a simple base to form a

compact unit. A V-belt drive is used, thus eliminating the need of an idler pulley.

The condenser is water-cooled. The water valve is automatically opened when the machine is operating, by an attachment on the outer end of the compressor shaft. A safety feature is included so that the machine will not operate should the supply of cooling water fail.

The operation of the machine is controlled by a thermostat placed in the food compartment. The motor starts or stops automatically when the temperature in this compartment varies only a few degrees.

An expansion valve is used to control the supply of refrigerant to the cooling coil. The household model uses only a few ounces of liquid ammonia in the entire system.

This machine is supplied with a cooling element to be placed in the ice compartment of the customer's refrigerator. This cooling element consists of a direct-expansion coil and a sharp freezer of steel pipe in which ice cubes or frozen desserts may be made. A cast iron sleeve is inserted in the horizontal part of this direct-expansion coil to form the sharp freezer.

Larger automatic machines are built for installations requiring a larger capacity machine.

Keith Electric Refrigerating Machine.—Fig. 18 shows an ammonia absorption household refrigerating machine and part of the cabinet in which it is installed. This machine is manufactured by the Keith Electric Refrigerator Co., of Toronto, Canada, by the Delco-Light Co., of Dayton, O., and the Keith Electric Refrigerator Corp., of Buffalo, N. Y.

Operation.—The steel tank marked generator, contains water. The boiler contains liquid ammonia. These two parts are connected by steel pipes and the whole arrangement is mounted on a pivot point as indicated, and is free to rock slightly on this pivot point.

The boiler is located inside the refrigerator proper, while the generator is located in an outside compartment.

In operation, a stud, (ice lock) attached to the boiler, freezes into a small cup of water, attached to the lining of the

refrigerator. After all the liquid ammonia has boiled away, and is absorbed by the water in the generator, the ice lock stud is released by the melting of the ice in the cup, and as the generator is now several pounds heavier than the boiler, the whole unit rocks slightly on the pivot point, until the heater leads enter the mercury switch cups, which turns the current on an electric heating coil located inside the generator.

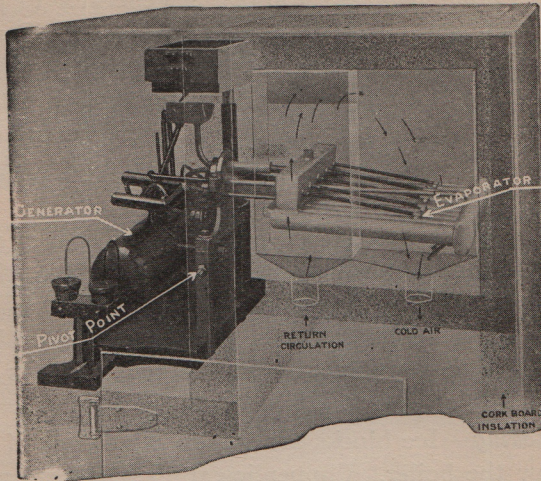


FIG. 18.—KEITH ELECTRIC REFRIGERATOR.

The electric heater now drives the ammonia vapor out of the water in the generator, and through a precooler to the boiler-condenser, where the vapor is cooled by water trickling over the tubes and condenses to a liquid. After this has continued for about three-quarters of an hour, most of the ammonia has been driven from the water in the generator and liquefied in the boiler. This part is now several pounds heavier than the generator, and the whole machine rocks slightly on the bearing, opening the electric mercury switch, and diverting the supply of water which has been trickling on the boiler, so that it passes through a coil of pipe inside the generator.

The effect of cooling the solution in the generator is to make it absorb the ammonia, and it dissolves the vapor in

the machine, quickly lowering the pressure. This causes the liquid ammonia in the boiler to boil at a low temperature and in a few minutes the whole boiler is white with frost. This initiates the refrigeration period which lasts for from four to six hours, that is, until all the liquid ammonia has boiled away and been absorbed in the generator, thus completing the cycle.

Mercury Seal.—A mercury seal or valve is used, which permits the vapor from the top of the generator to pass into the boiler during the heating part of the cycle. During the cooling period, the mercury seals this line and forces the vapor returning from the boiler to take another path which opens below the surface of the liquid in the generator. The vapor dissolves quickly and completely as it bubbles up through this liquid.

Water Cooling System.—A water trough rocks with the machine. It distributes water to the boiler during the part of the cycle when it functions as a condenser, and to the generator during the cooling part of the cycle. The boiler is really a condenser-evaporator, while the generator is a generator-absorber.

Ice Making.—Ice blocks are frozen in a series of cups located below the boiler. Copper ice studs sloping down from the boiler at an angle of about 45 degrees, dip into these cups when the boiler is down, and ice is made in the cups partly by contact with the copper studs and partly by the cold air from the boiler. Just before the machine rocks to the condensing position, the ice blocks thaw slightly around the sides, and are freed from the cups, permitting the machine to rock when the ice-lock melts. The blocks of ice are carried up out of the cups by the studs because they are on an angle, and then slide far enough forward off the studs to fall clear of the cups into a hopper which delivers them to an ice container, located on the top shelf in the refrigerator where they are readily available for use. These cups, and also the ice-lock cup, are automatically filled with water, which empties into the cups at the beginning of each refrigerating period.

Safety Valve.—The safety valve consists of a silver disc about $\frac{1}{2}$ inch in diameter and $1\frac{1}{2}$ thousandths of an inch

thick, mounted on a steel cup connected with the precooler, by a small steel tube. If the pressure exceeds 250 pounds per

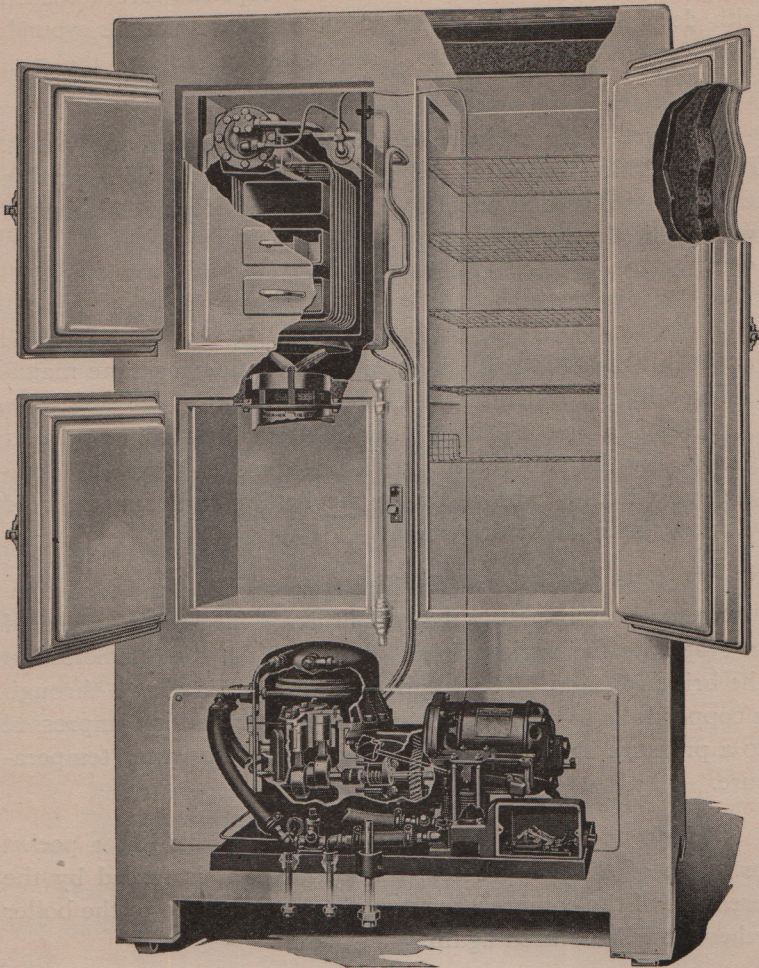


FIG. 19.—FRIGIDAIRE REFRIGERATING MACHINE.

square inch, this disc ruptures, and the ammonia is very slowly discharged into a trap formed in a water well.

Mercury Switch.—The switch consists essentially of two cups, shaped like “non-spillable” ink wells, containing a little

mercury. The two wires lead from the heater dip into the mercury when the machine is in the condensing position.

Electric Heater.—This consists of a soapstone core, threaded with deep narrow grooves, in which nichrome wire is wound. This element fits snugly into a steel tube welded into the generator.

Cabinet.—The cabinet has a food storage space of 7 cu. ft. The insulation consists of 3 inches corkboard. The outside casing is of plywood panels. The lining is of porcelain baked on steel of the one-piece type.

Frigidaire.—Fig. 19 shows a refrigerating machine manufactured by the Delco-Light Co., of Dayton, O.

This is a motor-driven household machine, using sulphur dioxide for the refrigerant. It is designed to form one complete unit with a cabinet, or the mechanical unit may be used with any standard refrigerator.

Cycle of Operation.—The heat from the food and food compartments is absorbed by the cold brine. This heat is then used to evaporate the liquid sulphur dioxide in the coils immersed in the brine solution. The sulphur dioxide gas is drawn through a copper tube to a motor-driven compressor and is compressed to a pressure at which it will condense at tap water temperature.

The condensed or liquid sulphur dioxide falls into a pocket or sump of the compressor, from whence it is forced by the pressure of the compressor through a copper tube to the boiler where it will be used again.

The flow of the sulphur dioxide into the boiler is regulated by means of a float valve, which keeps the proper amount of refrigerant available in the evaporating coils all the time. The float valve also reduces the pressure of the liquid as it enters the coils. Evaporation takes place in the coils continuously but it is much more vigorous while the compressor is running.

The motor starting and stopping device is controlled by the temperature of the brine, the motor starting when a temperature of 24° F. is reached and stopping when the brine is 16° F.

Compressor.—The compressor is a two-cylinder, vertical, single-acting type. It operates at a relatively low speed of 430 r.p.m. A gear drive is used. The double eccentric is keyed to a straight shaft. The suction valves are of the port type and are uncovered by the pistons at the bottom of the stroke. The discharge valves for both cylinders are of the "flapper valve type." The condenser consists of a coil of copper tubing inside the dome directly over the two cylinders. The stuffing box is of asbestos and graphite. The wear is automatically taken up by a spring. The stuffing box is sealed on both sides with oil. The compressor is mounted on three swivel rings to reduce noise and vibration.

Motor.—The compressor is operated by a $\frac{1}{4}$ -hp. motor. A small composition motor pinion is used to mesh with a cast iron gear upon the compressor shaft, the latter gear running in a bath of oil.

A repulsion-induction type motor is used. Oil to the bearings is supplied from the compressor gear in the oil bath by a tube from the gear case to both motor bearings.

Cooling Unit.—The cooling unit consists of the following parts:

1. The brine tank.
2. The boiler and evaporating coils.
3. The float valve.
4. The ice tray.

The brine tank serves as a storage reservoir for heat. It surrounds the evaporating coils and contains 54 pounds of calcium chloride brine. The brine tank is made of copper.

The boiler is partly submerged in the calcium chloride brine. A series of parallel copper tubes encircle the ice trays and return to the boiler. The "flooded" system of cooling is used; therefore these tubes are filled with liquid sulphur dioxide at all times.

The float valve is located inside the boiler. It automati-

cally controls the supply of liquid refrigerant to the boiler and evaporating coils. This valve is attached to the head of the boiler and operates similar to a carburetor float valve. The compressor removes sulphur dioxide gas from the boiler, and the float valve automatically replenishes the supply by allowing liquid sulphur dioxide to enter, thus maintaining a constant level of liquid sulphur dioxide in the evaporating coils and the boiler.

Three ice trays are used in the brine tank. These have a total capacity for 9 lbs. of ice made in 72 cubes. Six to eight hours are required to freeze the three trays full of ice. These trays are made of sheet copper heavily tinned.

Thermostatic Control.—The starting and stopping of the motor is controlled by a thermostat with the liquid bulb placed in the calcium brine. Methyl chloride is used to charge the thermostat. This control is so set that the motor will start when the brine reaches a temperature of 24° F., and will stop when the temperature has been reduced to 16° F. A sylphon bellows transmits the pressure through knife edge contacts to raise a gravity weight and operate the starting switch.

Automatic Water Valve.—When the compressor is in action, a pressure of about 55 pounds is built up in the condensing chamber. This pressure is piped to the water valve bellows which expands, thus raising the lever and gravity weight, opening the water valve to the condensing coil. If the condensing water supply is relatively warm, the pressure will be greater and the valve will open wider, thus automatically regulating the amount of water used in accordance with its initial temperature. When the compressor stops, the condensing pressure is reduced and the gravity weight closes the water valve.

Safety Shut-Off.—A safety device is used to prevent the operation of the unit when the condensing pressure is above a certain predetermined point. This feature is accomplished by means of an interlocking lever between the water control medium and the thermostat control lever. If the water supply should fail for a certain period, the machine would automatically function normally when the supply was resumed.

Cabinets.—Three sizes of cabinets are supplied. The mechanical unit is built in a machine compartment in the bottom of the box. These cabinets have 5, 9, and 15 cu. ft. capacities in the food compartments. The mechanical unit is also sup-

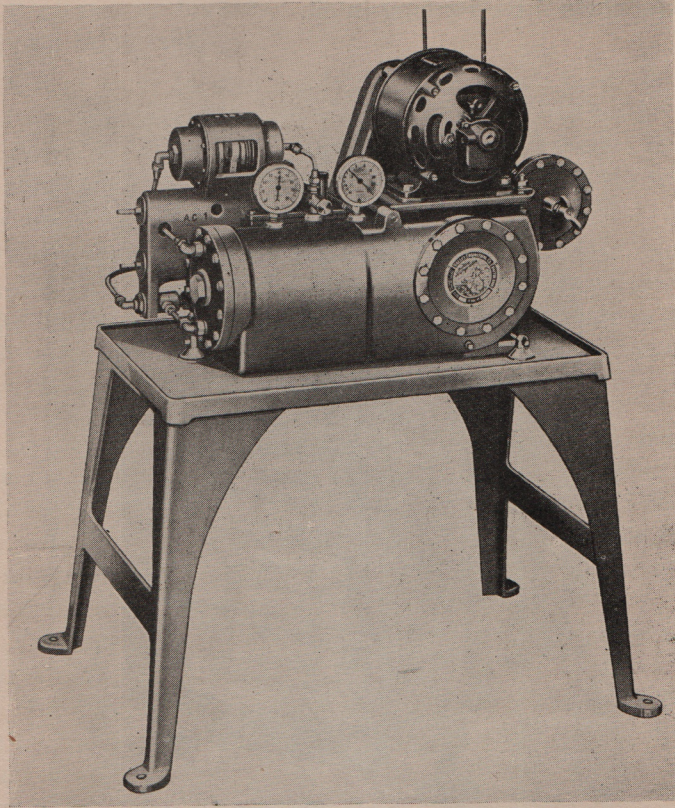


FIG. 20.—VALLEY ENGINEERING CO. MACHINE.

plied with the necessary cooling and ice making unit to fit in any standard ice refrigerator.

Fig. 19 shows also the wall construction of the cabinets. These walls are insulated with 2 inches or 3 inches of solid corkboard cemented to the porcelain lining with hydrolene, an odorless and tasteless asphalt.

Valley Engineering Co. Units.—Fig. 20 shows the household refrigerating machine made by the Valley Engineering Company of Dayton, O.

The refrigerant used is sulphur dioxide. The compressor is a single-acting, single-cylinder type, mounted horizontally. The compressor is driven by a 1/6-hp. motor by means of a special chain drive running in oil.

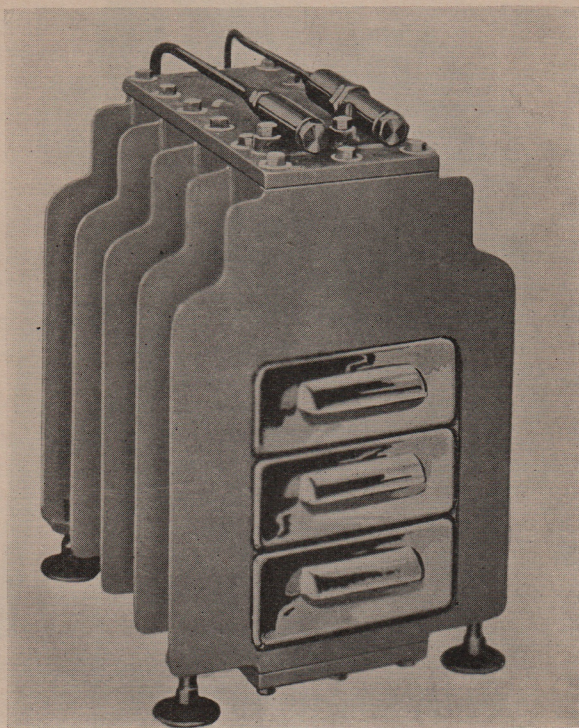


FIG. 21.—VALLEY COOLING UNITS.

Water is used as a cooling agent for condensing the sulphur dioxide gas and is automatically controlled, permitting only the amount of water to pass through the condenser that is required to properly condense the sulphur dioxide. The amount of water used is approximately one cubic foot per hour during the time the machine is operating.

Fig. 21 shows the cooling unit. This unit is made of aluminum and operates on the flooded principle. The vertical fins provide a considerable increase in cold surface for cooling the circulating air. The opening in the center contains slides for the ice trays. The large unobstructed space thus provided is convenient for freezing and holding sherbets and ice cream in tall glasses or buckets. This construction eliminates the need of a brine tank.

A float valve located inside the cooling unit controls the supply of liquid refrigerant. Two different size units are manufactured. The small size will refrigerate cabinets up to 10 cubic feet food storage capacity, the larger size up to 20 cubic feet.

For larger refrigerators, two or more cooling units are mounted horizontally or vertically in parallel. The capacity of the Type A machine (1/6-hp. motor) is one large or two small units. The capacity of Type B machine (1/3-hp. motor) is two large or four small cooling units.

Hygienic Cold Maker.—The H. C. M. household refrigerating machine is of the compression type, using sulphur dioxide as the refrigerant. The compressor is of the multi-piston type, with a slide transmission so that it is directly driven from the motor at 1,750 revolutions a minute. A special valve has been constructed to take this high speed.

This machine is being produced by the Hygienic Cold Makers, San Francisco, Cal.

The condenser is watercooled. The motor is 1/6-hp. The cooling system consists of a brine tank. An expansion valve controls the supply of liquid refrigerant to the coils immersed in the brine solution.

The compressor is an eight piston pump direct driven at 1,750 r.p.m. A drive block and yoke are used between the motor and compressor shaft. The condenser is water-cooled and consists of a steel tube with internal water coils. An expansion valve controls the supply of liquid refrigerant to the cooling coil. The cooling coil is made of copper tubing.

Isko (First Model).—The first model Isko machine is described as follows:

The motor operates the compressor and is controlled through the thermostat and the circuit breaker. When the refrigerator gets warm the thermostat starts the motor, which runs until a predetermined low temperature is attained and then stops. The thermostat is located in the cooling coil where the greatest variation of temperature is, there being nearly 32 degrees of variation under average conditions. The thermostat alternates on from 2 to 4 degrees of variation.

Isko cools the refrigerator by abstracting the heat through the tinned copper ice-making coils in which liquid sulphur dioxide is being boiled by the heat extracted from the refrigerator.

This sulphur dioxide steam, unlike the steam with which we are most familiar, is cold (14° F.). This is sucked into the compressor at atmospheric pressure and elevated in both temperature and pressure to the corresponding temperature of the room.

In the condenser (which is a coil of pipe surrounding the apparatus as a guard), this warm sulphur dioxide steam loses its heat by radiation to the surrounding atmosphere, causing it to liquefy because it is under pressure.

The liquid coming out of the bottom of the condenser is fed automatically into the tinned coil inside the refrigerator by means of an expansion valve, which works intermittently to step down these condenser pressures to a pressure above atmospheric pressure.

Moisture abstracted from the refrigerator is deposited on the coil, and freezes, because the coil is at 14° F. The machine operates intermittently so that this frost does not accumulate. On the stand still period, the frost will melt and run off through the drain pipe of the refrigerator.

In the ice-making compartment it is possible in warm weather to make 32 cubes of ice in a day of 24 hours, automatically. Ice can be made in winter only when the refrigerator is in a well-heated room; otherwise the machine will run too small a percentage of the time.

The complete machine is supplied as a unit ready to run when connected to an electric light socket. The No. 1 size will take care of an ordinary refrigerator, not to exceed 55 sq.

ft. of internal exposed area when set over a hole 13 in.x13 in., in the top of the refrigerator. The actual weight of the apparatus is 175 pounds.

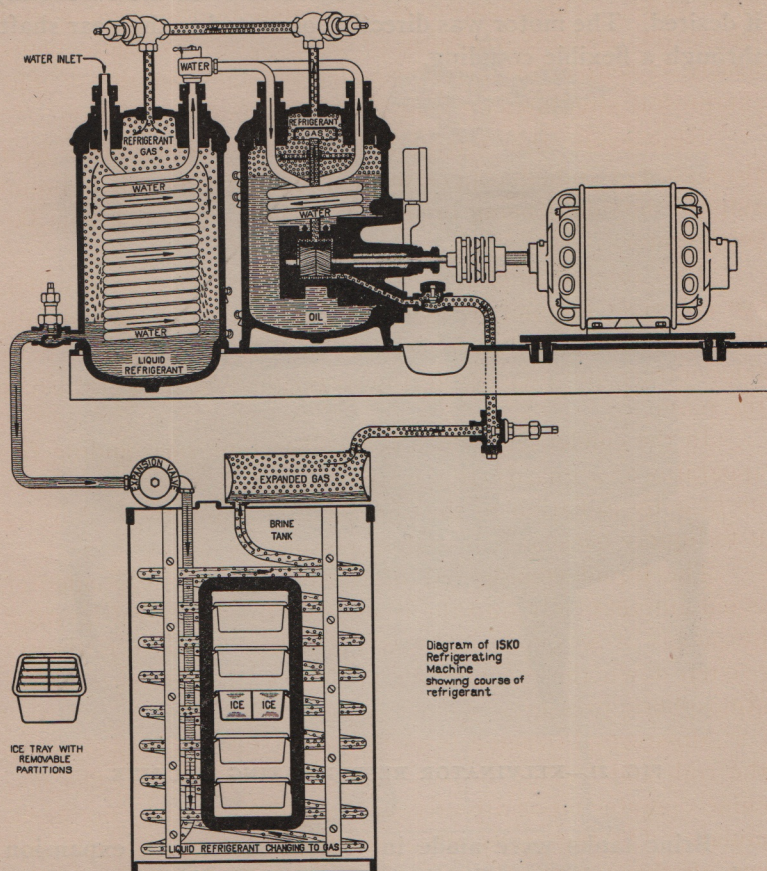


FIG. 22.—ISKO REFRIGERATING MACHINE.

Isko (Present Model).—The present model of the Isko machine is shown in Fig. 22. This machine was formerly manufactured in large quantities by the Isko Co., at Chicago.

The compressor was of the herringbone gear type, operating at motor speed submerged in a sealed chamber of oil. The gears were supplied with a small amount of oil to seal

them so that they would compress the sulphur dioxide gas, this being the refrigerant used.

The cylinder and motor were mounted on a single base to be placed on the top of the refrigerator or in the basement, if desired. The motor was directly connected to the gear shaft through a flexible coupling.

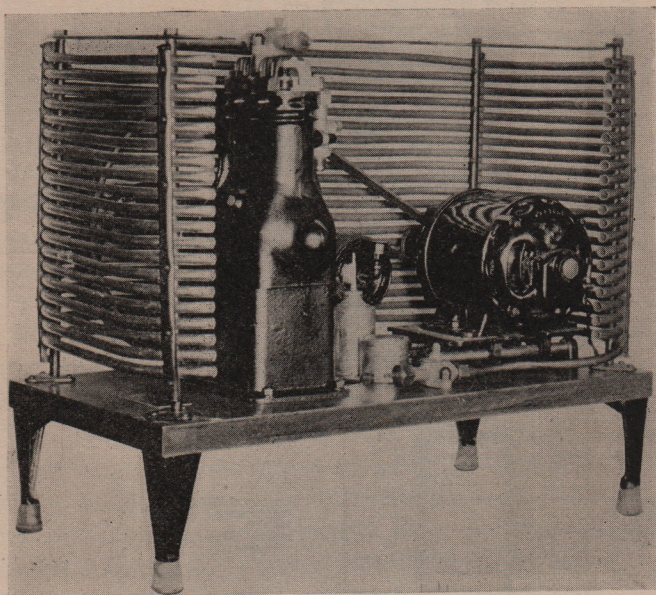


FIG. 23.—KELVINATOR REFRIGERATING MACHINE.

Brine tanks were made in various sizes. An expansion valve was used, expanding into a copper tube immersed in the brine.

A small header was used on the suction line between the evaporating coil and the compressor to prevent frosting back to the machine.

The condenser was water cooled by means of a copper coil inside the condenser cylinder. Part of the cooling water circulated through a coil in the compressor cylinder, in order to cool the oil in which the gears operate.

Full automatic controls were used to maintain a uniform temperature inside the refrigerator.

Kelvinator.—Fig. 23 shows the refrigerating machine made by the Kelvinator Sales Corporation at Detroit, Mich.

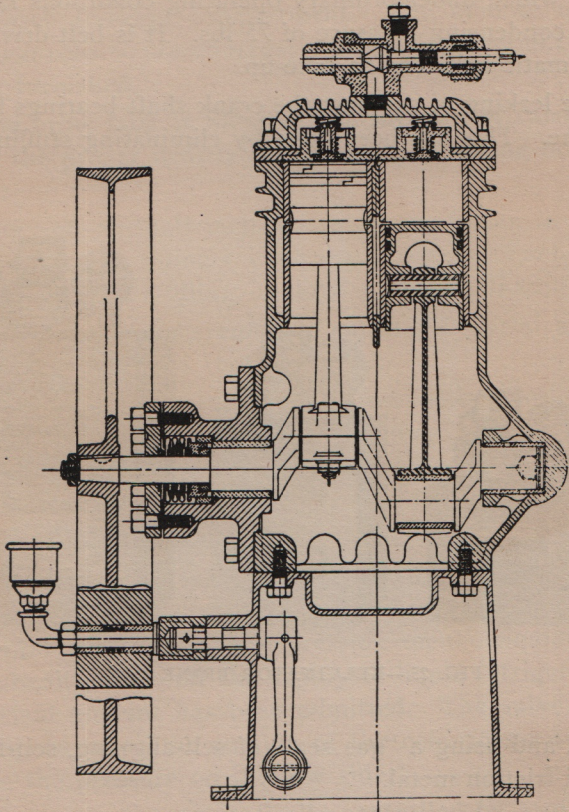


FIG. 24.—KELVINATOR COMPRESSOR.

This is a motor-driven domestic refrigerating machine, designed for installation in any refrigerator of standard construction. The refrigerant used in this system is sulphur dioxide.

The air-cooled condensing element consists of the motor, compressor, and the condensing coils, mounted on a single base. This is installed in the basement or other out-of-the-way place.

There are two sizes of compressors, a one-cylinder for the smaller boxes and a double-cylinder for the larger refrigerators.

The compressor is of the reciprocating type, shown by Fig. 24, which under ordinary operating conditions rarely exceeds a condensing pressure of 75 lbs. It is belt-driven, with an automatic belt tension take-up.

The leaking of gas past the crank shaft bearings has been overcome. This has been done by eliminating stuffing boxes

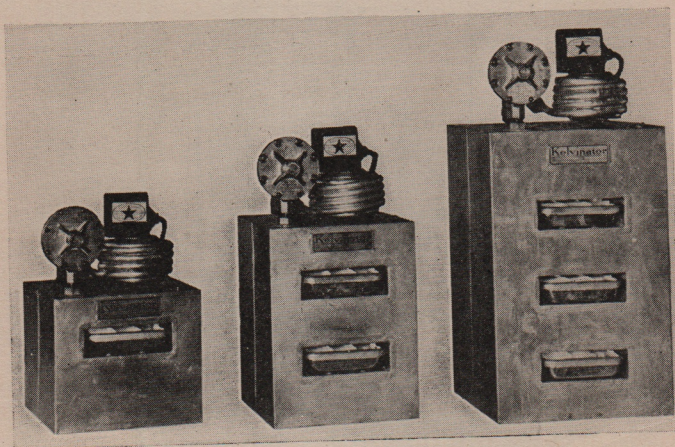


FIG. 25.—KELVINATOR BRINE TANK.

entirely, and using a "gas seal" of self-aligning, self-lubricating, anti-friction metal.

The condenser is a coil of $\frac{1}{2}$ -in. seamless copper tubing, wound spirally on a rectangular form. It is air-cooled and is therefore not dependent on any water supply for its proper operation.

The refrigerating element consists of the brine tank, the expansion coils inside the brine tank and the expansion valve, and thermo coil which holds the thermostat on top of the brine tank. This element is installed in the ice compartment of the refrigerator and is shown by Fig. 25.

The brine tank is of sheet copper, completely tinned. Its

size is dependent upon the size of the ice compartment in which it is to be placed.

The brine tank is equipped with from one to three ice-freezing compartments, according to the tank size. Expansion coils are placed within the brine tank in such a way as to surround each freezing compartment. The number of feet of expansion coils so placed largely controls the amount of refrigeration furnished.

The brine tank is filled with a solution of calcium chloride of the proper density to prevent its freezing down to 6° above zero.

One and one-half inch ice cubes are frozen in sufficient quantity to meet ordinary table requirements. Each tray will freeze 21 cubes at a filling, or three and one-half pounds of ice.

The automatic thermostatic control is placed within the thermo-coil on top of the brine tank.

The liquid refrigerant under pressure is admitted to the expansion coils of the brine tank through the automatic expansion valve which lowers its pressure to about two pounds gauge. At this pressure the liquid sulphur dioxide in the coils boils at a temperature of about 19° F.

The expansion valve is of the balanced pressure type. Increasing pressure on the low side, caused by the boiling refrigerant, acts against the pressure on the liquid side and automatically shuts off the supply of liquid refrigerant when a sufficient amount has been admitted. The valve automatically opens when the suction of the compressor sufficiently reduces the pressure on the low side.

The system is automatically controlled by a quick make and break switch, thermostatically operated. This opens and closes the motor circuit, as the temperature within the refrigerator rises and falls within fixed limits. The thermostat is of the syphon type, a corrugated metal bellows filled with gas, which by the expansion and contraction caused by changing temperatures, operates the make and break switch.

The actual time which the compressor runs will vary, of course, with the room temperature, the quality and degree of refrigerator insulation, the size of the refrigerator, etc. Under

ordinary conditions, however, the compressor will run eight hours a day.

The 1/6-hp. motor pulls (under load) 200 watts, which means about 1600 watts in one day, or 1.6 kw.-hrs. per day.

The 1/4-hp. motor pulls (under load) 300 watts, which means about 2,400 watts in one day, or 2.4 kw.-hrs. per day.

The box temperature should be at least 10 degrees colder than ice can keep the same box. The reason for this is that the surface of the brine tank is kept constantly at 22° F., while the surface of a cake of ice is 32° F.

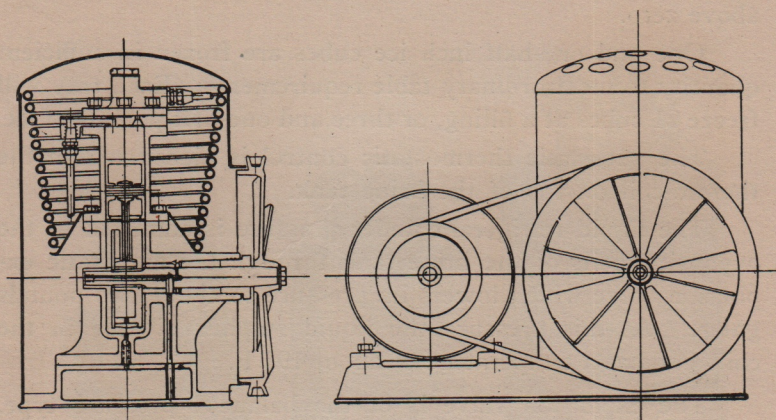


FIG. 26.—KOLD KING REFRIGERATING MACHINE.

Kold King.—Fig. 26 shows the household refrigerating machine manufactured by the Kold King Korporation at Detroit, Mich.

A single-cylinder, sulphur dioxide compressor, is used. The condenser is air-cooled and consists of 60 feet of copper tubing, forming a spiral coil around the compressor. A fan in the compressor fly wheel forces air over the condenser coil. The suction and discharge valves are of the flat steel flapper type. They are both located in the cylinder head plate. The compressor is driven by a 1/6-hp. split phase, repulsion-induction motor. A V-type belt is used for the means of driving.

A float valve system of expansion has been developed for regulating the cooling compartment. The thermostat is

crank case and is controlled by pressure. A brine tank is used which is placed in the ice compartment of the refrigerator.

The mechanical unit is supplied to refrigerate any stand-ard cabinet.

Polaris.—This is a compression type household machine, which was placed on the market about 1921 by the Universe Corporation at Chicago. The refrigerant is sulphur dioxide.

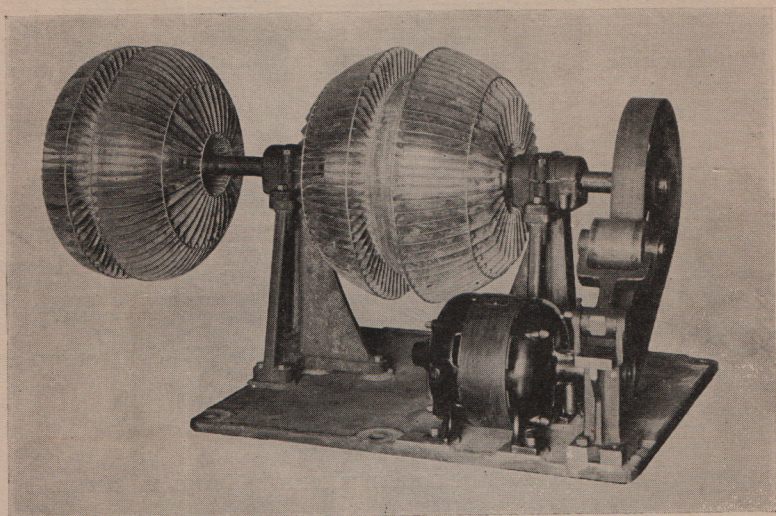


FIG. 27.—AUDIFFREN REFRIGERATING MACHINE.

The machine is installed in the lower part of a white enameled steel cabinet. The compressor is a single-cylinder of the vertical single-acting type.

A belt drive is used from a 1/6-hp. motor. The motor and compressor are mounted on a metal base which contains the air-cooled condenser coils. Forced air cooling is obtained by a fan directly connected to one end of the motor shaft.

The upper part of the cabinet has a single food chamber of 3½ cu. ft. capacity. On one side of the food chamber are located the expansion valve, cooling coils, and two ice making trays.

Circulation is obtained by means of a vertical baffle plate

around the cooling coils and open at the top and bottom. This arrangement eliminates the need of the ice or brine tank compartment.

The thermostatic control consists of a special coil inside the cooling coil unit, which operates the switch by means of metallic bellows in the machine compartment. A copper tube connects the liquid element of the thermostat to this copper bellows.

Audiffren Refrigerating Machine.—Fig. 27 shows the household refrigerating machines manufactured by the Audiffren Machine Co. of New York City. A sectional view of this machine is shown in Fig. 28.

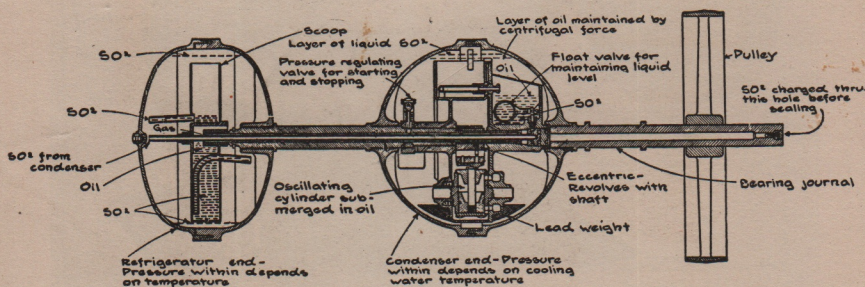


FIG. 28.—SECTION OF AUDIFFREN REFRIGERATING MACHINE.

This machine has an enclosed sulphur dioxide compressor. All of the operating parts are sealed up within this revolving "dumbbell," consisting of two bronze bells on a hollow shaft.

The machine is driven by a $\frac{1}{3}$ -hp. electric motor, the shaft revolving in two babbitt bearings and, as it revolves, one of the bells grows warm, while the other bell grows cold.

The cold air is furnished to the food compartment under pressure. The condenser is air-cooled, thus eliminating the need of water connections.

The complete mechanical unit, including the ice trays, is placed in the lower machine compartment.

Larger machines of this general type have been in commercial use in this country for over 15 years. A typical refrigeration installation is shown by Fig. 29.

Frigidaire Cooling Unit.—Fig. 30 shows the Frigidaire cooling unit, which operates on the flooded system.

The header contains a float valve which controls the supply of liquid refrigerant to the cooling unit.

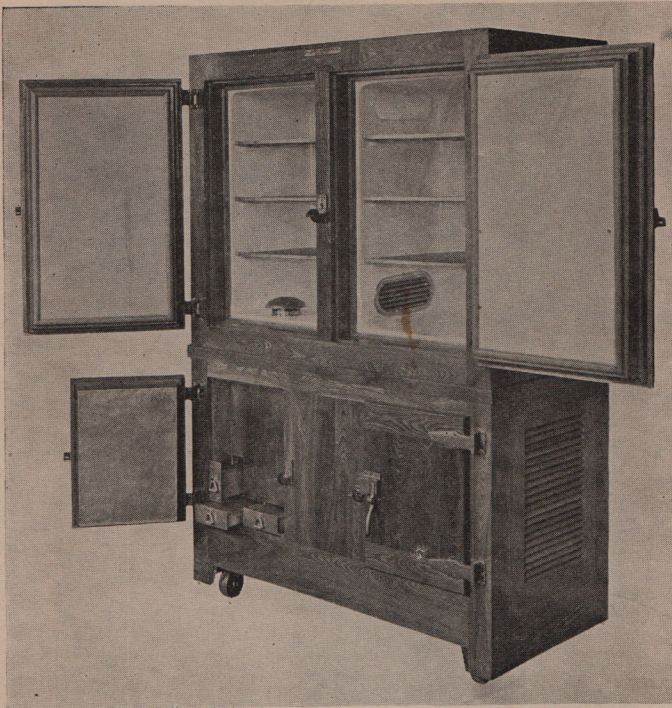


FIG. 29.—AUDIFFREN MACHINE IN REFRIGERATOR.

A series of parallel copper tubes surround the ice trays. The evaporation of the refrigerant in these tubes takes up heat from the circulating air in the refrigerator, and also takes heat from the water in the ice trays.

This direct cooling unit has replaced the brine tank formerly used with the Frigidaire system.

Frigidaire Air-Cooled Compressor Unit.—Fig. 31 shows the Frigidaire air-cooled compressor unit manufactured by the Delco-Light Co. at Dayton, O.

The refrigerant used is sulphur dioxide. The compressor is of the two-cylinder, vertical single-acting type. The suction gas enters the cylinders through ports. The discharge valves

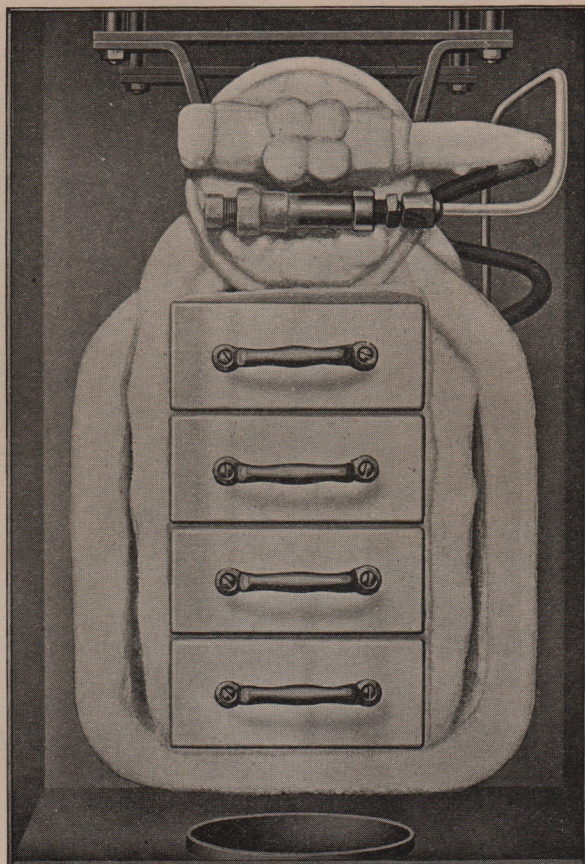


FIG. 30.—FRIGIDAIRE COOLING UNIT.

are of the flapper valve type. A single flat spring is clamped to the cylinder head and comprises both of the discharge valves. The cylinders are finned to provide proper cooling.

The condenser consists of two coils of copper tubing connected in parallel, located on two opposite sides of the compressor.

The compressor pulley has fan blades which force air over the two condenser coils and the compressor. This insures cooling when the compressor is operating.

A $\frac{1}{4}$ -hp. motor drives the compressor by means of a special V-type belt.

The automatic control switch is located on the same base. The switch is operated by means of a copper bellows respon-

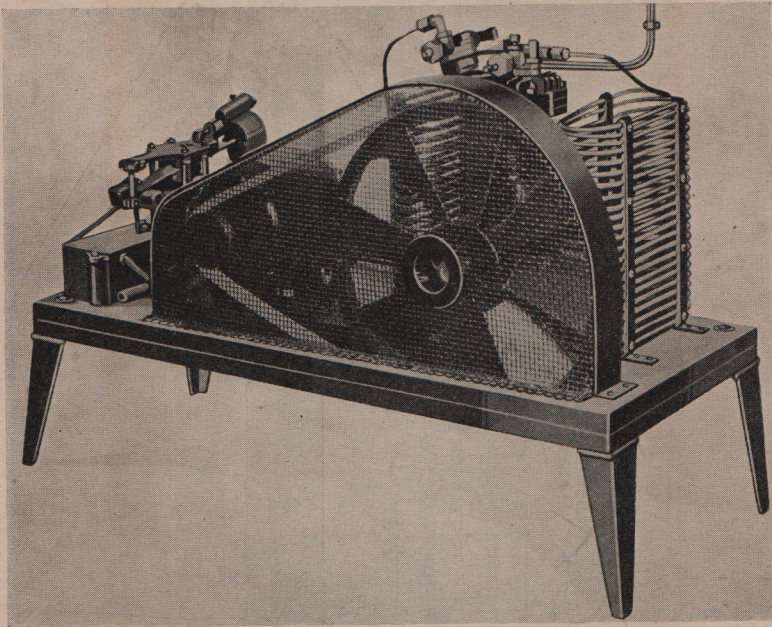


FIG. 31.—FRIGIDAIRE AIR-COOLED COMPRESSOR UNIT.

sive to the pressure on the suction side of the refrigerating system.

The receiver is carried under the base. Shut-off valves on the discharge, suction, and liquid lines of this unit facilitate installation and service work.

Autofrigor.—This machine, Fig. 32, is manufactured by Esher Wyss & Co. of Zurich, Switzerland.

The refrigerant is methyl chloride. The compressor (5) is double-acting, operating at motor speed. Gas from the suc-

tion chamber (6) is compressed into the pressure chamber (7). The compressed gas then passes through the vertical pipe to the high pressure gas chamber (8) and into the annular space surrounding this chamber. The condensed liquid collects in chamber (9). The gas is condensed by circulating water which enters by connection (11) and leaves by outlet (12). Nozzle (13) is used in place of an expansion valve to the evaporator (R).

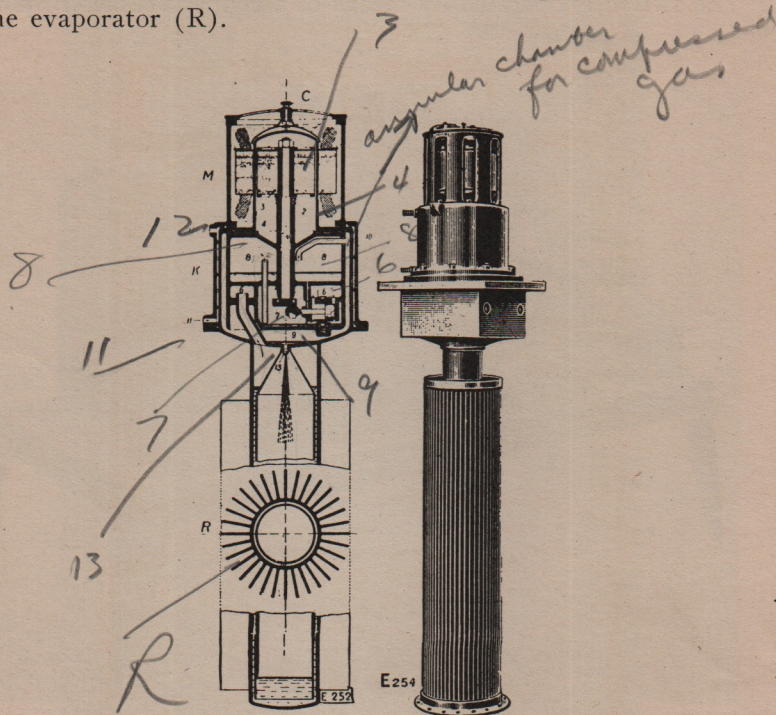


Abb. 2

Abb. 3

FIG. 32.—AUTOFRIGOR.

The motor (M) has its rotor (3) enclosed by a steel shell (4), which seals the gas chamber (8). This machine is manufactured in several sizes.

SerV-el.—The SerV-el refrigerating machine, illustrated by Fig. 33, for the home, is entirely automatic in operation. A flooded system is used, wherein approximately 85 per cent of the refrigerant is carried in the expansion coils. The equip-

ment consists of a two-cylinder compressor with air-cooled condenser, a sturdy float valve, a $\frac{1}{4}$ -hp. motor, and a positive pressure control switch, all mounted on a common base. Placed in the cooling chamber of the refrigerator is a tank containing a solution of alcohol and water to prevent any

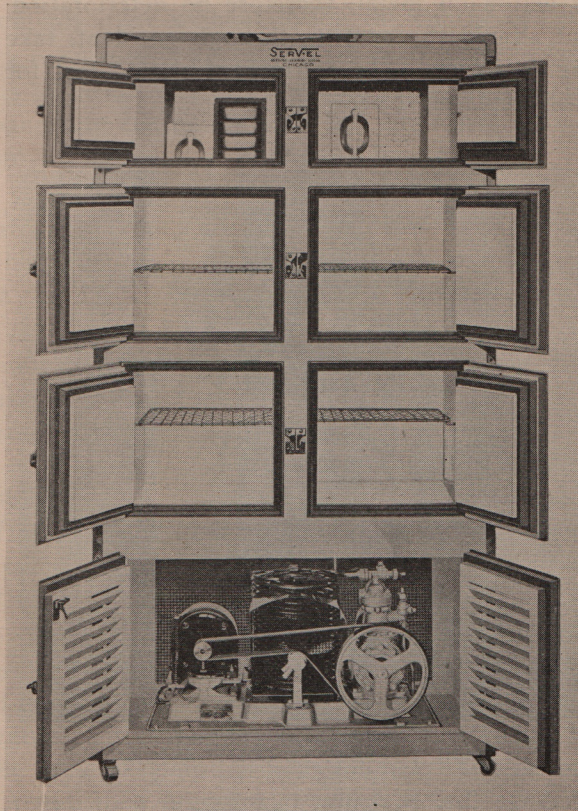


FIG. 33.—SERV-EL UNIT IN REFRIGERATOR.

corrosion that may follow in the use of calcium chloride or a brine solution. This cooling tank also contains core openings in which a quantity of ice is prepared for table purposes.

The only connection between the refrigerating machine and the refrigerator are two lengths of copper tubing, one placed within the other. There is no electric wiring or con-

trol equipment of any nature in the refrigerator when the machine is placed a distance from the box.

Methyl chloride (CH_3Cl) is the refrigerant used. It is safe to use in the home and is free from obnoxious odors. Should there be a leak of the refrigerant due to any accident or a defect in equipment, no injury will result. There is no corrosive action on metal, therefore no deterioration to the equipment should the system, through accident, take in air containing moisture. The refrigerant should last for years, but is easily replaced if necessary.

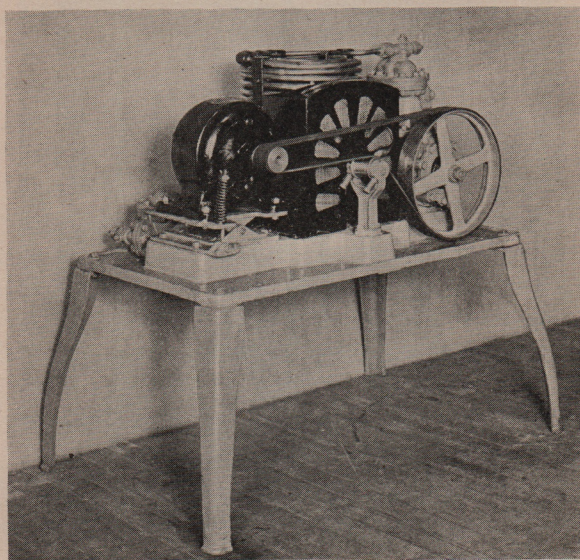


FIG. 34.—SERV-EL COMPRESSOR.

The compressor shown in Fig. 34 is two-cylinder slow speed, having case hardened inserted steel sleeves, mechanically operated inlet valves in the piston head, flat spring automatic discharge valves, and the crank shaft and connecting rods are steel dropped forgings. The bearings both on the crank shaft and connecting rods are of ample size for long service. A quantity of oil is used in the compressor base, which gives lubrication to all moving parts in the compressor. The compressor is fitted with two shut-off valves, permitting the

replacement of the compressor parts without losing the refrigerant. The seal or stuffing box is a unit made up of a steel bushing, having three bronze collars all revolving with the shaft. Spread on each of these bronze collars is a stationary disc of flat spring steel. This construction provides a labyrinth metal packing. This seal unit is packed with graphite grease, and if necessary at any time, may be replaced in a few moments' time without losing the charge of refrigerant.

The condenser is air-cooled. A draft of air is forced over the coils by means of a fan, operated on the return side of the belt connecting the motor and the compressor. Two grease cups provide lubrication to the fan bearings.

A $\frac{1}{4}$ -hp. motor is used, this being mounted on a hinge base which automatically takes up any belt stretch. The motor bearings have grease cup lubrication. On alternating current circuits, a repulsion-induction motor is used.

A simple float valve releases the refrigerant from a high to a low pressure. This float valve is mounted directly on the compressor base, and no adjustments are required.

Temperature control is secured by means of a pressure switch also mounted on the refrigerating machine base. By operating between two definite pressure limits on the low side of the refrigerant, a uniform temperature is maintained in the cooling chamber. Temperature control within a variation of two degrees is easily obtained by this method.

A cooling tank replaces the ordinary cake of ice in the refrigerator. This cooling tank is filled with a solution of alcohol and water. By maintaining this solution at an even temperature, a constant dry cold is obtained in the box.

The cycle of operation is as follows: Gas is compressed in the pump to a pressure at which it will condense when cooled. The liquid refrigerant then flows into the float valve, which is mounted beside the condenser on the machine base and in which it is released to the expansion coils in the cooling tank through the $\frac{1}{4}$ -in. copper tubing. The refrigerant then is evaporated into a gas as heat is extracted from the cooling tank and refrigerator. The refrigerant in form of gas is then returned to the compressor where it is again compressed and condensed.

To obtain the best results, a well insulated refrigerator should be used. The following shows material in Model 12, which is the unit complete with box:

1. White porcelain—steel lining with round corners.
2. One inch dead air space.
3. Five-eighths inch wood panel lining.
4. Layer of prepared insulating paper.
5. Corkboard 2 inches thick and fitted into frame and cemented.
6. Layer of prepared insulating paper.
7. Twenty gauge automobile sheet metal, white enameled.
8. Corners and edges of doors trimmed with Perm-o-Britt metal.
9. Brass hinges and locks, heavy nickel.

In this model are eight trays, each holding 12 cubes of ice, $1\frac{1}{8}$ in. x $1\frac{1}{2}$ in. x $1\frac{3}{4}$ in., or 96 cubes. A total of 288 cubes, or approximately 27 lbs. of ice, can be easily made in 24 hours.

The following tabulation shows the dimensions of Model 12, in inches:

	Height	Width	Depth
Overall	74	41	$25\frac{1}{2}$
Food Compartment	$30\frac{3}{8}$	35	16
Cooling Chamber	$13\frac{1}{4}$	35	17
Machine Section	18	37	19

The SerV-el machine is manufactured by the SerV-el Corp., Chicago, Ill.

Coldak.—The Coldak household refrigerating machine is made at Springfield, Mass.

Ethyl chloride is made to expand or evaporate in a copper coil immersed in a brine tank.

As the liquid ethyl chloride expands into a gas it absorbs heat from the brine. This chills the brine. The cold brine chills the adjoining compartment.

The ethyl chloride gas passes to the compressor. Here it is squeezed to reduce its volume.

The squeezing or compressing of the ethyl chloride gas has heated it. It is cooled and liquefies in the condenser.

From the condenser the liquid ethyl chloride passes again to the brine tank to be expanded into a gas, and so the process is repeated over and over again.

A compound rotary gear compressor is used to compress

the ethyl chloride gas which is used as the refrigerant. This is a two-stage compressor and operates at motor speed. The compressor is self-lubricating.

The air-cooled condenser consists of a tubular radiator placed either on the back of the cabinet or in the cellar.

The motor is equipped with an automatic oiler, containing a visible supply of oil. A spring coupling between the compressor and the motor forces the armature in its proper electrical field.

An expansion valve controls the supply of liquid ethyl chloride to the copper coil in the brine tank. The brine is automatically held at an average temperature of 22° F.

Two sizes of machines are made, the $\frac{1}{4}$ -hp. model for refrigerators of 20 cu. ft. or less inside volume, and the $\frac{1}{2}$ -hp. model for 20 to 40 cu. ft. cabinets.

Powrkold.—The Powrkold household refrigerating machine was made at Albany, N. Y.

This was an ethyl chloride system with a rotary compressor. An electric motor was used with a flat belt drive. The compressor element was mounted on a base with the brine tank underneath. In this way, the entire mechanical and cooling unit could be assembled and installed by dropping the brine tank through a hole in the top of the cabinet. The condenser was water-cooled.

This mechanical unit was made to be installed in the owner's cabinet.

Williams Simplex Refrigerating Machine.—Fig. 35 shows a cross-section view of the compressor of the motor-driven domestic refrigerating machine made at Brooklyn, N. Y., by the Simplex Refrigerating Corp.

Ethyl chloride is the refrigerant employed. This is a stable neutral gas which condenses at the lowest pressure of any of the commercially applicable refrigerants, its pressure averaging about 22 lbs. per sq. in. in the air-cooled machines.

Glycerine is employed for lubricating the interior of the compressor. Its specific gravity being greater than that of the refrigerant, and there being little or no affinity between these two substances, the problem of separation is eliminated.

The compressor is of the rotary type, directly connected to the motor shaft without employment of intermediary gearing or belting.

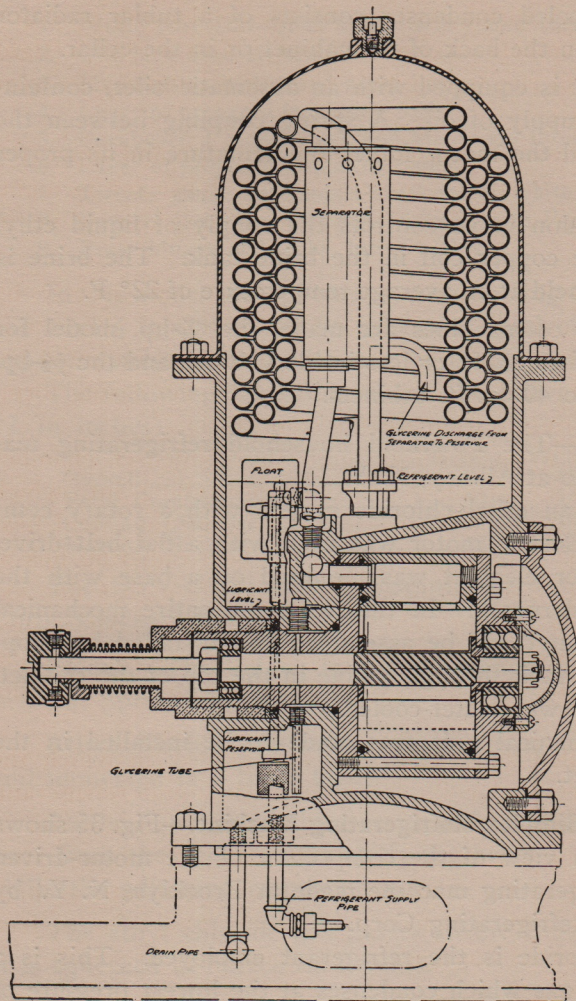


FIG. 35.—WILLIAMS REFRIGERATING MACHINE.

The compressor has a volumetric efficiency ranging from 82 per cent to 85 per cent, and a mechanical efficiency comparing favorably with the best reciprocating types of many times greater capacity.

A ground steel collar is used to seal the drive shaft. This collar is self-aligning and automatically takes up wear, as it is attached to the compressor by means of a corrugated metallic tube. A spring, assisted by the condensing pressure, holds these members in firm contact. This forms a tight joint, which will run indefinitely without a tendency to wear or break down.

The compressor is mounted integrally with and supported by the motor. Positive pressure feed of lubricant is maintained to all moving elements of the compressor while in operation.

The compressor and condenser are cooled entirely by maintaining a current of air over their surfaces. The air is circulated by means of a Sirocco type of blower mounted between the motor and the compressor, the blower casing forming the supporting bracket for the compressor.

The air is first drawn through the condenser chamber which contains a continuous coil of copper tubing, into which the refrigerant vapor is compressed, taking up the latent heat of vaporization; it then passes over the heat radiating fins of the compressor, from which it discharges through a flue extending through the top of the machine cover. Air is also simultaneously drawn from the opposite direction through and around the motor and discharged from the fan as above described.

The so-called flooded system is employed, in which the expansion or cooling coils are filled with liquid refrigerant. These coils connect into a vertical header from the top of which the vaporized refrigerant is drawn. This vapor, after being liquefied in the condenser, is discharged into a small chamber fitted with a float valve, which permits it to feed back into the expansion coils at the same rate at which it is being condensed.

These features are important, in that the radiating surfaces of the cooling coil have a much higher heat transmitting capacity when full of liquid. The ratio to the usual method of gas expansion at constant pressure is about 1.56 to one.

A still more important advantage is that the expansion pressure is automatically varied to maintain constant balance

between the compressor capacity and the radiating surfaces as the temperature changes. This provides maximum efficiency operating conditions throughout any range of temperature, while in the usual gas expansion method the pressure is necessarily set and held for the lowest temperature required which is always the condition of lowest efficiency.

The machine is controlled by means of a thermostat, arranged to operate responsive to the temperature of the brine surrounding the coils in the brine tank. The switching apparatus and its actuating motor are located on the machine base, while the bulb of the instrument only is located in the tank. The advantage of placing the thermostat bulb in the brine tank is due to the fact that the maximum temperature change occurs in the brine.

A safety pressure switch is also used, which is operated directly responsive to the refrigerant condensing pressure.

The machine has a capacity when operating at 15° F. of about 150 lbs. ice equivalent per 24 hours. The power consumption, including motor losses, is from 190 to 200 watts with direct current, and from 260 to 300 watts with alternating current, the difference being due to the larger losses in the alternating current motor.

Motorrefrigerator.—Fig. 36 shows a domestic refrigerator manufactured by the Motorrefrigerator Co., Lansdale, Pa. The refrigerant used is ethyl chloride. The operating unit in the lower compartment consists of a motor, pump and condenser coil. This unit is assembled and tested before being placed in the lower part of the refrigerator.

The compressor is driven by a 1/6-hp. motor mounted on a sliding base. A spring maintains the proper tension on the belt, which runs in grooved pulleys, thus eliminating the need of an idler pulley.

The thermostat is located in the food compartment directly beneath the rectangular flat, expansion coil. This coil is placed in the space above the food compartment.

The expansion valve is attached to the expansion coil and located in the same compartment. It is automatic in operation, and is entirely controlled by the capacity of the pump.

The open coil system is used without a brine tank. The

present machines are not equipped with attachments for freezing water into ice cubes but provision has been made for this to be installed later.

The condensing coil consists of 90 feet of $\frac{3}{8}$ -in. copper tubing. The condensing coil is air-cooled, the machine compartment being open in the back with a slot in the front permitting free circulation of air. Fan blades on the pump pulley force the air over the condensing coil.

The full charge of ethyl chloride for a machine is $\frac{3}{4}$ lb.

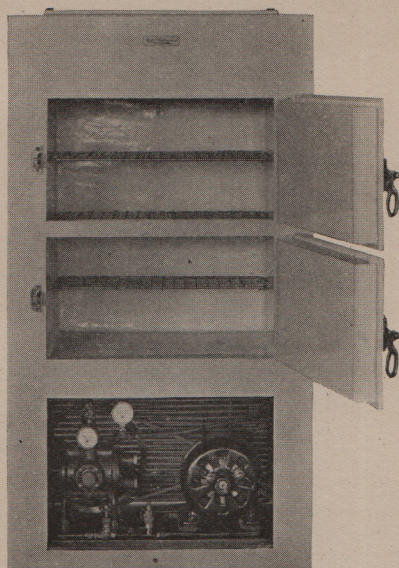


FIG. 36.—MOTORFRIGERATOR.

Due to the fact that such small quantities of ethyl chloride and glycerine are used in these machines, it is not necessary to provide glycerine separating devices of any kind.

The pump is a double-acting, horizontal, reciprocating type with 3-in. bore and $\frac{1}{2}$ -in. stroke. It operates at about 260 r.p.m. An especially designed piston ring is used on each end of the piston. The valves are arranged in the cylinder heads so that they may be readily replaced. The intake valves are in the top of the cylinder heads. The circulation through the pump is so arranged that any glycerine carried

up into the expansion coil will find its way back by gravity and the suction of the pump, through the intake valves and the discharge valves to the middle of the cylinder. This insures lubrication of all the working parts with the minimum amount of glycerine.

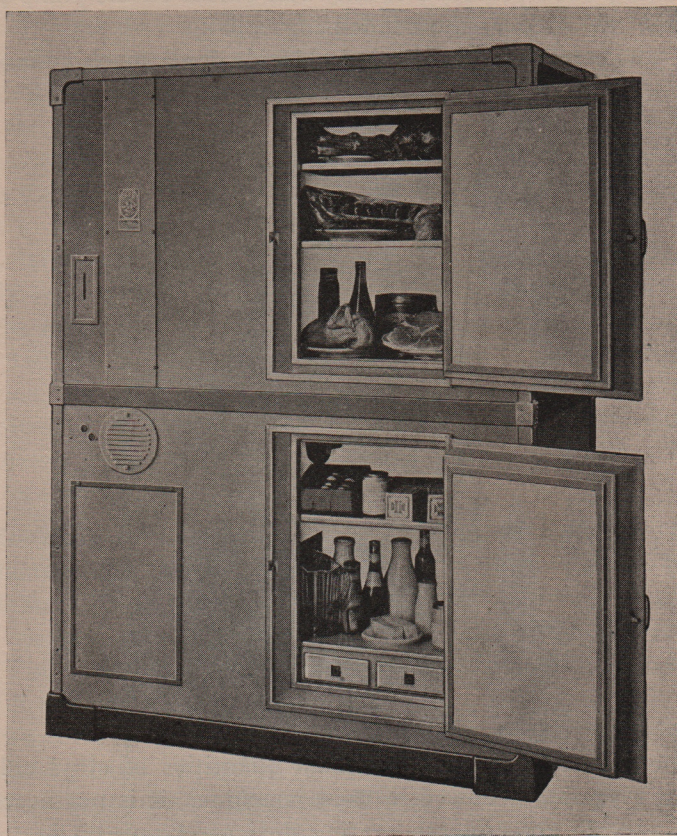


FIG. 37.—ODIN REFRIGERATING UNIT.

The outside dimensions of the box are: Width 28 inches, depth $21\frac{1}{2}$ inches, and height 50 inches. The total weight, completely equipped, is 350 lbs.

Odin.—The Odin refrigerating machine is made by the Automatic Refrigerating Co., of Hartford, Conn.

This machine uses air under very low pressure for a refrigerating medium. The machine is entirely automatic. A thermostat in the food compartment automatically starts and stops the refrigerating machine. This system is air-cooled, thus eliminating cooling water connections.

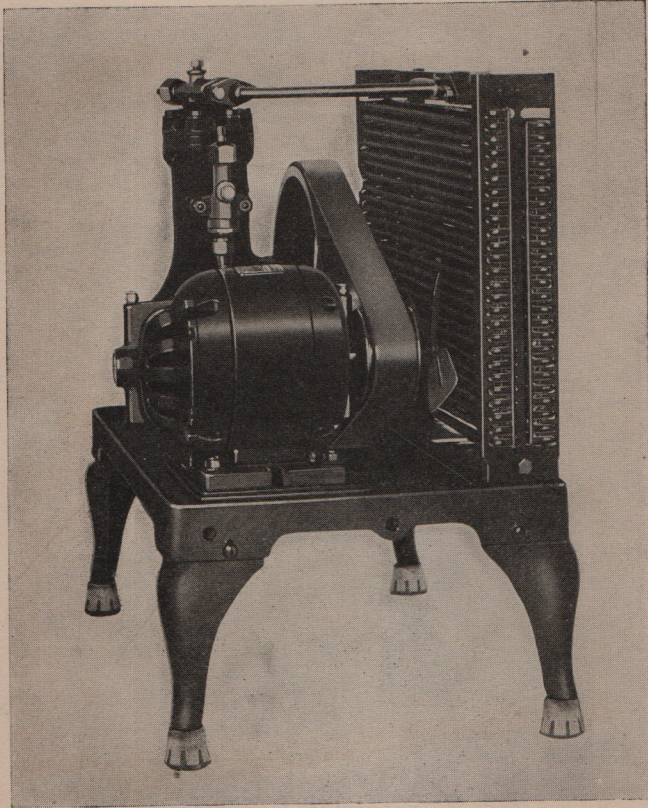


FIG. 38.—COPELAND REFRIGERATING UNIT.

The cabinet, Fig. 37, has 15 cu. ft. of food compartment space. An ice making compartment is included. This box has a grey enamel finish on the outside and porcelain fused on a metal lining.

Copeland Refrigerating Machine.—Fig. 38 shows a house-

hold refrigerating machine made by the Copeland Products Corp., of Flint, Mich.

The compressor, Fig. 39, is driven by an electric motor by means of a flat belt. The drive is so designed as to eliminate the use of an idler pulley.

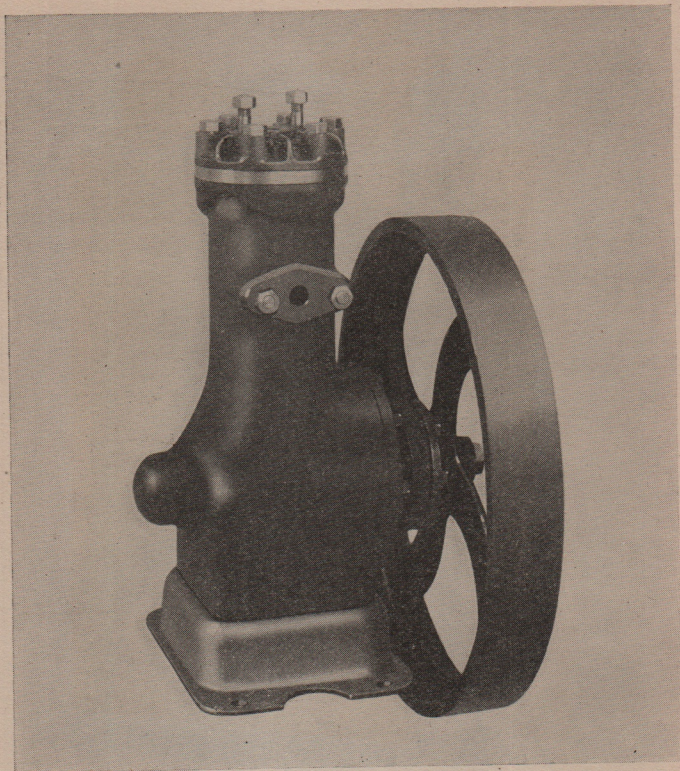


FIG. 39.—COPELAND COMPRESSOR.

The refrigerant used is butane, claimed to be non-corrosive, non-poisonous, and odorless.

The compressor is of the two-cylinder, vertical single-acting type. A new type valve is used in the compressor.

An air cooled condenser is used. This is constructed of copper tubing. Air is forced over the condenser by a fan attached to the motor shaft.

The cooling units consist of a brine tank, Fig. 40, of special construction. An expansion valve is used to regulate the supply of liquid refrigerant to the coils in the brine tank.

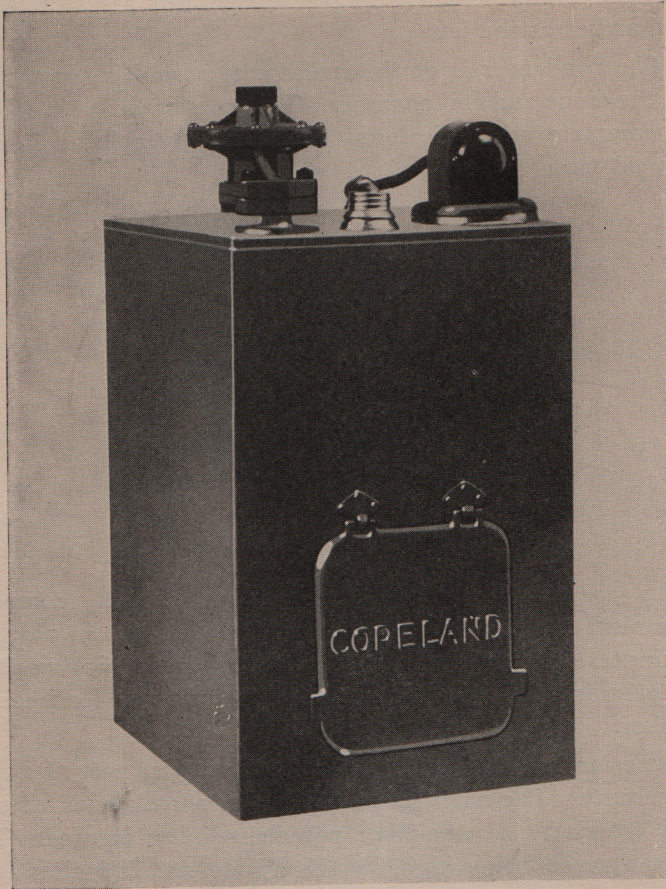


FIG. 40.—COPELAND BRINE TANK.

This machine is entirely automatic in operation, using a thermostat control.

Utility Refrigerating Unit.—Fig. 41 shows the mechanical unit used in the Utility Electric Refrigerator which is manufactured at Adrian, Mich., by the Utility Compressor Co.

The electric motor and pump are enclosed in the dome at the right, hermetically sealed. This eliminates a packing gland for the shaft of the compressor.

The thermostat and the cooling coils, which absorb the heat from the atmosphere in the refrigerator are situated in the chamber at the left.

The condenser is of the radiator type and is located behind the dome and coil chamber. This condenser is air cooled. The complete mechanical unit is interchangeable and easily removed from the cabinet.

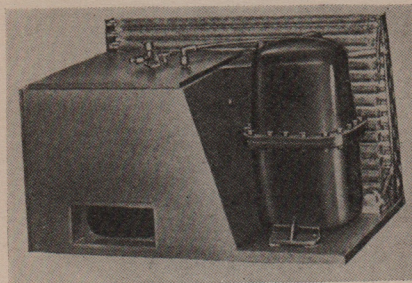


FIG. 41.—UTILITY REFRIGERATING UNIT.

In case service is required, it is claimed that the complete mechanical unit can be removed and another put in place in 15 minutes. This eliminates the need of mechanics working on repairs in the home. The small door is for the ice freezing chamber.

The mechanical unit is placed in the upper part of a special cabinet. The cabinets are of white porcelain or natural wood exteriors. A one-piece porcelain lining is used. The cabinets are 70 inches high, 38 inches wide, and 23 inches deep.